Prunus Vulnerability Statement

Prunus Crop Germplasm Committee

I. Introduction

Stone fruit production in the U.S. is worth over $2 billion. About 80% of the processing peach crop is grown in California which also produces about 50% of the fresh market peaches and 90% of the nectarines. South Carolina and Georgia produce another 25% of the fresh market peach crop with the remaining crop being produced by another 30 states. Most Japanese plum and apricot production is in California. California is the major prune plum producer followed by Oregon, Washington, Idaho and the Great Lakes region. A limited amount of plums is produced in the Southeast. Fresh market sweet cherries are produced mainly in Washington and Oregon followed by California, with a significant amount being produced for brining in the Great Lakes States. Most tart cherries are produced in Michigan (1st), New York (2nd), Oregon (3rd), Pennsylvania (4th) and Utah (5th). All commercial almonds are produced in California (Table 1).

There has been an increase in the demand for fresh fruit and a decrease in demand for processed stone fruit. The increase in fresh fruit consumption is in part due to a greater awareness of the health benefits but it is clear from consumer surveys that increased quality is needed to promote repeat sales and continued increased demand for stone fruit.

Table 1. Stone Fruit Production in the United States 1,000 short tons.

SPECIES	1996	1997	1998
Peaches	1,052	1,312	1,212
Plums and Prunes	952	917	542
Apricots	79	139	118
Cherries	273	388	362
Nectarines	247	264	230
Almonds	412	594	469

Source: Noncitrus Fruits and Nuts, 1998 Preliminary Summary, Jan. 1999, USDA, National Agric. Stat. Serv.

II. Present Germplasm Activities.

The National Clonal Germplasm Repository in Davis, California was established to preserve all *Prunus* germplasm, except for the tetraploid cherries (including tart cherries) which are preserved at the NCGR in Geneva, NY and the ornamental *Prunus* which are housed at the National Arboretum in Washington, D.C. There are a number of public institutions involved in breeding and these programs usually have working collections of material of interest to them. There are a few arboretums that also have limited collections of Prunus. Those programs also doing rootstock breeding are marked with an (*).

Major Prunus Breeding Programs and/or Prunus Collections in North America.

A. Peaches/Nectarines

Davis, CA – Chuck Simon - NCGR

Davis, CA - Tom Gradziel - University of California
*Fresno, CA - David Ramming, Craig Ledbetter - USDA/ARS
Bakersfield, CA - David Cain, Sun World, Inc.
Fresno, CA - John Slaughter, Burchell Nursery
*Modesto, CA - Floyd Zaiger, Zaiger Genetics
Le Grand, CA - Norman and Glen Bradford
College Station, TX - David Byrne - Texas A&M University
Fayetteville/Clarksville, AR - John Clark, Curt Rom - University of Arkansas
Cream Ridge, NJ - Joseph Goffreda - Rutgers University
Kearneysville, WV - Ralph Scorza - USDA-ARS
Raleigh/Jackson Springs, NC - Dennis Werner - North Carolina State University
*Clemson/Pontiac, SC - Greg Reighard and William Newell - Clemson University
*Byron, GA - Dick Okie and Tom Beckman - USDA
Baton Rouge, LA - Charles Johnson - Louisiana State University
Benton Harbor, MI - William Shane - Michigan State University
Calhoun, LA - Charles Graham - Louisiana Experiment Station
Gainesville, FL - Wayne Sherman - University of Florida
Prosser, WA - Ken Eastland
Benton Harbor, MI - Paul Friday, and Ms. Bjorge, private breeders
Coloma, MI - Annette and Randy Bjorge - Fruit Acres Farm
Queretaro, Mexico - Salvador Perez - Universidad Autonoma de Queretaro
Chapingo, Mexico - Jorge Rodriguez - Colegio de Postgraduados, Chapingo
Vineland, Ontario, Canada - Neil Miles - University of Guelph

B. Plums

Davis, CA - Ted DeJong, Jim Doyle (*P. domestica*)
Fresno, CA - David Ramming
Fresno, CA - David Cain - Sun World
Modesto, CA - Floyd Zaiger
Le Grand, CA - Norman Bradford
Delano, CA - Tim Bourne - Marko Zaninovich (*P. domestica*)
Prosser, WA – Ken Eastland
Geneva, NY - Bob Anderson (*P. domestica*)
Byron, GA - Dick Okie - USDA
College Station, TX - David Byrne, Texas A&M University
River Falls, WI - Brian Smith
Excelsior/St. Paul, MN - Jim Luby
Traverse City, Michigan - Jim Nugent (*P. domestica*)
Gainesville, FL - Wayne Sherman, University of Florida
Vineland, Ontario, Canada - Frank Eady - University of Guelph

C. Apricots

Davis, CA – Clay Weeks, Chuck Simon - NCGR
Davis, CA - Steve Southwick - University of California
Fresno, CA - Craig Ledbetter - USDA
Modesto, CA - Floyd Zaiger - Zaiger Genetics
Le Grand, CA - Norman Bradford
Prosser, WA - Gregory Lang - Washington State University
Cream Ridge, NJ - Joseph Goffreda - Rutgers University
Byron, GA - Dick Okie - USDA
College Station, TX - David Byrne - Texas A&M University
Vineland, Ontario, Canada - Helen Fisher - University of Guelph

D. Sweet Cherries

Davis, CA – Chuck Simon, NCGR
Prosser, WA – Ken Eastland - NSRP5/IR2
Prosser, WA - Greg Lang - Washington State University
Traverse City, MI - Jim Nugent
Geneva, NY - Robert Anderson - Cornell University
Logan/Brigham City, UT - David Walker
Mt. Vernon, WA - Gary Moulton
Lodi, CA - Marvin Nies - private breeder
Vineland, Ontario, Canada - Frank Eady - University of Guelph
Summerland, B.C., Canada. - Frank Kappel - AAFC

E. Tart Cherries

East Lansing/Clarksville, MI - Amy Iezzoni - Michigan State University
Geneva, NY - Phil Forsline - NCGR
Excelsior/St. Paul, MN - Jim Luby
Davis, CA – Chuck Simon, NCGR

F. Almonds

Davis, CA - Chuck Simon - NCGR
Davis, CA - Tom Gradziel - University of California
Le Grand, CA - Norman Bradford
Modesto, CA - Floyd Zaiger

G. Species & Interspecific Hybrids

Byron, GA - Dick Okie and Tom Beckman
Clemson, SC - William Newell
Gainesville, FL - Wayne Sherman
College Station, TX - David Byrne
Prosser, WA - Ken Eastwood
Davis, CA - Chuck Simon - NCGR
Davis, CA - Tom Gradziel - University of California
*Fresno, CA - Craig Ledbetter - USDA/ARS
Fresno, CA - David Ramming
*Modesto, CA - Floyd Zaiger
*Clarksville, AR - Curt Rom and John Clark
River Falls, WI - Brian Smith
Calhoun, LA - Charles Graham
Washington D.C. - Margaret Pooler - US National Arboretum (ornamental cherries)

American Horticultural Society has list of Arboreta and Botanical Gardens containing Prunus.

The International Board for Plant Genetic Resources (IBPGR) has developed a database for Prunus held at 45 locations in Europe. They have also supported collection trips for Prunus.

North American Groups with which interaction is desirable for input into Prunus germplasm decisions.

A. Prunus Breeders Group.
   This is an informal organization of Prunus breeders from throughout the world, but mostly from the U.S., Canada and Mexico that meet yearly to exchange knowledge.
B. The American Society for Horticultural Science - Fruit Breeding Working Group.
C. The American Society for Horticultural Science - Genetics and Germplasm Working Group.
D. The American Pomological Society.
E.. The North American Fruit Explorers - An organization of private and hobby fruit enthusiasts.
F. NC-140 - North Central Regional Rootstock Committee.

G. NRSP5/IR2 - Inter-regional Virus Indexed Fruit Repository.
H. FPMS - California Foundation Plant Material Service.
I. National Peach Council.
J. Ontario Fruit Testing Association.
K. California Rare Fruit Growers.
L. Okanagan Plant Improvement Co. Summerland, B.C. Canada.
M. South Carolina Certification Board
N. California Genetic Resources Conservation Program
O. Northern Nut Growers
P. California Tree Fruit Agreement
Q. Almond Board of California
R.

European Groups.
A. International Plant Genetic Resources Institute - Prunus Working Group.
B. International Society for Horticultural Sciences - Working Groups related to Prunus.
 Apricot Breeding and Culture
 Cherry Production
 Peach Culture
 Plum and Prune Genetics
 Nut Production (almond)
 Rootstock Breeding and Evaluation
C. Prunus Genetics Group of Europe.
D. Rootstock Group of Europe.
E. United Kingdom Plant Genetic Resources Group
F. N. I. Vavilov All-Russian Scientific Research Institute of Plant Industry
G. Nordic Gene Bank
H. EUCARPIA

III. Statement of Crop Vulnerability.

Commercial stone fruit cultivars have an extremely narrow genetic base. Inbreeding analyses have been done on various populations of peaches (Eastern cultivars, Florida low chill cultivars, and California processing germplasm) and Japanese-type plum germplasm (Scorza et al., 1985; 1988; Gradziel et al., 1993; Byrne, 1989; Byrne and Bacon, 1999). These studies have shown that peaches share much common parentage within the various germplasm pools. For example, the peach cultivars from the Eastern USA have 6 commonly used parents and show very high levels of inbreeding. The available nectarine cultivars trace back to four cultivars. Japanese plum cultivars had coancestry and inbreeding coefficients 1/2 or less of those calculated for peaches. More recent studies using isozymes and molecular markers to evaluate the genetic diversity among *Prunus* has indicated that within the germplasm in the USA there is low diversity among peaches, low to intermediate among the apricots, and medium to high diversity among the Japanese plum germplasm (Byrne, 1990). A survey of RAPD polymorphisms within the peach germplasm collection at the Clonal Repository clearly shows the US peach/nectarine germplasm is very narrow and can be grouped into three closely related clusters. In contrast, the few Chinese accessions in the study were grouped separately from the US germplasm and showed much more diversity than within the US germplasm (Warburton and Bliss, 1996). This same trend is revealed in various studies of isozyme and morphological polymorphisms among cultivated peaches (Arulsekar et al., 1986; Byrne, 1990; Durham et al., 1989; Ibanez et al., 1993; Messeguer et al., 1987; Mowrey et al., 1990; Perez et al., 1993; Werner, 1992) Within the Japanese plum germplasm, the higher level of diversity is due to the incorporation of disease resistance genes from related species into the germplasm developed in the Southeastern USA. Unfortunately, among the California germplasm, much less variability exists. This reflects the fact that these cultivars can be traced back to only a few introductions of *Prunus salicina* and one introduction of *P. simonii* from China (through Japan). A recent introduction of *P. salicina* from Taiwan is very distinct from other *P. salicina* introductions available in the USA which would indicate that much more variability exist within this species in its center of diversity (Boonprakob, 1996).

The entire tart cherry industry is based on the 400 year-old ‘Montmorency’ cultivar which is considered an inferior cultivar in many European countries. Sweet cherry production is mostly in Washington (1st), Oregon (2nd) and California (3rd). ‘Bing’ accounts for 75% of the fresh market sweet cherry crop. Apricots have such a limited amount of genetic variation in adaptive traits that they can be grown commercially in only a few isolated regions of the U.S. Romanians can not grow the U.S.-developed apricot cultivars because of disease susceptibility indicating a narrow gene base. Greater than 50% of the apricot production in California is from a few cultivars. The apricots grown for the fresh market in California and Michigan generally have one cultivar, “Perfection” as a common parent. Plums have a broader genetic base than other commercial *Prunus* species, but still the vast majority of commercial fresh market plums grown in the U.S. are Japanese types which are grown in California, but are not adapted to other growing regions. ‘French’ prune accounts for 96% of the prune production on the West Coast and ‘Stanley’ accounts for almost all the European plum production in the Eastern United States. ‘Nonpareil’ accounts for over 50% of the almonds produced in the U.S. A number of *Prunus* species which may possess desirable traits are not available in the U.S. or are represented by only one or two clones. Bailey’s Hortus Third (2) states there are over 400 species in the genus *Prunus*, but only 89 are listed in the Genetic Resource Information System.

Compared to agronomic crops, stone fruits are much more susceptible (genetically vulnerable) to insect and disease pests. At present, the application of various pesticide sprays per year is common practice in the production of fruit. Because of their high value, however, it is still economically feasible to do so. This economic advantage of spraying is fast declining as available chemicals become more limited and expensive, in response to the greater awareness of the ecological and safety risks involved in their use. Thus the susceptibility of stone fruits to brown rot, peach scab, mites, bacterial leaf spot, bacterial canker, peach tree borers, and other pests needs to be countered from a genetic angle, but high resistance for all these pests does not appear to exist among the commercial germplasm. Many crops could not be economically grown if specific chemicals were banned. The use of dibromochloropropene (DBCP) for postplant nematode control in peaches and its subsequent banning is a classic example of dependence on chemical control because of genetic susceptibility. Now there is also the likely loss of methyl bromide and ethylene dibromide. Peaches, plums, cherries and apricots are all susceptible to brown rot, mites, peach tree borers and bacterial canker. There are also many diseases which attack specific species such as peach leaf curl and cherry leaf spot. Major diseases and insects are listed in Tables 3 and 4.

Stone fruit crops are susceptible to a range of environmental stresses such as mid winter cold damage, fluctuating winter temperatures, and warm winter conditions which limit the regions in which they can be cultivated (Table 5). China has *Prunus* species adapted to the range of environments from the severe winters of the north to the sub tropical areas of the southern part of the country. Much of the breeding for low chilling adaptation and cold hardiness, has depended on a few Chinese introductions for germplasm. Unfortunately, few of these accessions exist which has restricted the breeding efforts.

Postharvest disease and handling is even more of a problem in stone fruits than other fleshy fruit tree crops because of their susceptibility to diseases and their short storage life (Table 6). Almonds are an exception because the seed is used instead of the fleshy pericarp. Brown rot and Rhizopus rot are major problems and the cost of control and resultant losses are extensive. Storage disorders, such as internal browning, internal breakdown, flesh mealiness and skin blemishes which are accentuated in the handling and storage process cause large losses. Sources of resistance to brown rot, Rhizopus rot, internal disorders, and better firmness and shelf life need to be located and incorporated into commercial cultivars.

With the rapid changes in technology, fruit growing is becoming more mechanized. Conceptually, fruit farms are becoming more like factories, producing a constant supply of uniform products. This results in forcing an old cultivar into a new role for which it is not ideally suited. Orchards are being forced to less adaptable sites (regards soil moisture and frosty conditions) as well. This necessitates the need for stocks and scions with new adaptability characteristics in addition to those of machine adaptation. Virtually all tart cherries are mechanically harvested as are many prune plums, cling peaches and almonds. Growers are planting all fruit crops at higher densities to obtain quicker returns on high capital investments. Yet, there are few dwarfing rootstocks in *Prunus.*

At a time when rapid changes in agricultural technology would seem to warrant increased breeding efforts to adapt cultivars to this new technology and ecological awareness, there continues to be a reduction in breeding efforts. Many state and federal programs have been reduced due to inadequate budgets or have been eliminated entirely. This is critical to *Prunus* germplasm preservation because since the closing of the USDA Plant Introduction Station at Chico, CA, germplasm collections have been held by a few individual plant breeders in state and federal programs. These breeder collections are located in climates not suitable for all germplasm. Much of the

Chico material has already been lost and much more exists as one or two unhealthy specimens in individual collections. Many times, these specimens are the only representatives of a species available in the U.S. The work should continue to put all of these in the clonal *Prunus* collection at Davis.

Since Asia and Europe are the centers of origin of most of our commercial *Prunus* species (Table 2), most of our germplasm has been imported. Historically, obtaining germplasm from these centers of diversity has been extremely difficult because of political differences between these countries and the U.S. When our imported germplasm is lost, it is unlikely that it will be readily replaced. In addition to political policies, it will be difficult to obtain germplasm from some locations because wild germplasm forests are rapidly being removed and local cultivars are being replaced with a few cultivars of world wide importance.

Table 2. Major Centers of Diversity of Cultivated Prunus Species.

Species	Centers of Diversity
Almond	China, Central Western Asia, Europe
Apricot	China, Central Asia
Cherries	Europe, Asia
Peach	China, Central Western Asia
Plums	Asia, Europe, North America

Native *Prunus* species exist in diverse climates ranging from subarctic regions to dry deserts where they are subjected to high and low temperatures, high and low moisture conditions, variable soil conditions and a host of insects and diseases. While little is known about the range of desirable characteristics possessed by many wild species, but many of these species are known to possess useful characteristics such as cold hardiness, drought tolerance and small tree size. For example, evergreen *Prunus* species exist, but very little is known about their characteristics and usefulness. These species now have limited value because they cannot be hybridized with commercial species. Little is known about hybridization potential between other genera but varying levels of compatibility exist between species within *Prunus*. Future developments in in-vitro and genetic engineering technology will undoubtedly allow more of the related genera to be used as sources of genetic material.

A partial listing of major genetic vulnerabilities can be found in Tables 3-6. A more comprehensive treatment of specific diseases attacking these species can be found in Anderson (1956), Kester et al. (1990), Iezzoni et al. (1990), Mehlenbacher et al. (1990), Ramming and Cociu (1990), USDA/ARS (1976), and Wilson and Ogawa (1979).

IV. Germplasm Needs.

A. Collection

The current germplasm collections in the United States are limited. The North American species have not been adequately collected. The species in China were last collected before 1940 and many of those introductions have been lost (Fogle and Winters, 1981).

IBPGR has developed the European Cooperative Program for the conservation and exchange of Crop Genetic Resources (ECP/GR) for the conservation and exchange of Prunus germplasm. These holdings will not be beneficial to the United States unless the introduction of Prunus germplasm can be made more efficient by increasing the number of importations possible and decreasing the time it takes to test imported material.

The number of clones of a species available in the United States as listed in GRIN and held in the National Germplasm Repository (Davis) are shown in Table 7. The American Horticultural Society in 1975 had a listing of 29 Arboreta in the U.S. and they show 104 species of Prunus in these collections.

Table 7. Prunus Species listed in The Germplasm Resource Inventory Network (GRIN) compared to those in the National Plant Germplasm (NPGR) Collection at Davis, CA.

	Species	1989 # Accessions In NPGR, Davis	1996 # Accessions In NPGR, Davis	1999 # Accessions in NPGR, Davis	1996 # Accessions In GRIN
Almond	**(*P. dulcis*)**	**92**	**92**	54	**120**
	P. argentea	3	7	2	8
	P. bucharica	0	7	4	8
	P. fasciculata	31	4	4	4
	P. fenzliana	0	2	0	2
	P. *fremontii*	1	2	2	2
	P. glandulosa	4	2	2	3
	P. scoporia	0	1	1	4
	P. spinosissima	0	2	1	4
	P. tangutica	0	2	1	2
	P. triloba	0	2	1	2
	P. webbi	3	8	3	8
Apricot	**(*P. armeniaca)***	**20**	**216**	**171**	**570**
	P. ansu	2	0	0	0
	P. x *dasycarpa*	3	2	6	2
	P. divaricata	20	1	7	13
	P. mandshurica	0	1	3	3
	P. mume	3	24	5	7
	P. sibirica	0	0	1	1

Table 7 (cont.) Prunus Species listed in The Germplasm Resource Inventory Network (GRIN) compared to those in the National Plant Germplasm (NPGR) Collection at Davis, CA.

	Species	1989 # Accessions In NPGR, Davis	1996 # Accessions In NPGR, Davis	1999 # Accessions In NPGR, Davis	1996 # Accessions In GRIN
Sweet Cherry	***P. avium***		**192 (3)** [GN]	**92**	**298**
Tart Cherry	***P. cerasus***		**59 (43)** [GN]	**32 (65)** [GN]	**223**
	P. cerasoides ssp.	0	5 (8) [NA]	0	17
	P. caroliniana	0	0	0	0
	P. cerasoides	0	1 (4) [NA]	0	11
	P. conradinae	0	0	0	0
	P. cyclamina	0	0	0	0
	P. dawyckensis	0	0	0	0
	P. emarginata	1	1	1	1
	P. fruticosa	36	11 (12) [GN]	3(7) [GN]	24
	P. incisa	0	10 (24) [NA]	0	37
	P. jacquemontii	0	2	1	2
	P. japonica	1	2	1	7
	P. laurocerasus	1	2	0	2
	P. lusitanica	0	0	0	0
	P. mahaleb	7	15 (2) [GN]	11	22
	P. maximowiczii	0	1 (4) [NA]	0	5
	P. nipponica	0	10 (31) [NA]	0	41
	P. okame	0	0	0	0
	P. padus	38	12	5	13
	P. pleiocerasus	6	1	1	1
	P. prostrata	0	5	3	6
	P. pseudocerasus	1	1	1	2
	P. pubescens	0	0	0	0
	P. sargentii	0	23 (85) [NA]	0	111
	P. serotina	1	9	14	10
	P. serrulata	7	7 (13) [NA]	2	35
	P. subhirtella	0	6	0	7
	P. virginiana	1	7	2	7
	P. x *kanzakura*	0	0 (1) [NA]	0	1
	P. x *yedoensis*	0	10 (16) [NA]	2	28

Table 7 (cont.) Prunus Species listed in The Germplasm Resource Inventory Network (GRIN) compared to those in the National Plant Germplasm Collection (NPGR) at Davis, CA.

	Species	1989 # Accessions In NPGR, Davis	1996 # Accessions In NPGR, Davis	1999 # Accessions In NPGR, Davis	1996 # Accessions In GRIN
Peaches and Nectarines	***P. persica***	**138**	**311 (1)**	**233**	**601**
	P. davidiana	1	3	3	3
	P. fenzliana	0	2	0	2
	P. kansuensis	1	2	2	3
	P. mira	0	1	3	3
	P. tenella	0	2	2	4
European plum	***P. domestica***		**174 (2)** GN	**141**	**254**
Japanese plum	***P. salicina*** ***P. hybrid***	**92(16)**	**114(10)** NA/GN	**40** **59**	**137**
	P. alleghaniensis	0	13 (1) GN	3	14
	P. americana	1	6	4	6
	P. andersonii	0	0	3	4
	P. angustifolia	2	4	15	4
	P. besseyi	5	12	1	12
	P. bokhariensis	4	1	4	1
	P. cerasifera	14	29	32	49
	P. cistena	1	0	0	01
	P. domestica ssp institia	0	11	1	12
	P. hortulana	3	4	0	4
	P. maritima	50	10	2	10
	P. mexicana	15	4	2	4
	P. minutiflora	0	2 (1)	0	3
	P. munsoniana	0	2	1	2
	P. nigra	0	3	1	3
	P. pumila	1	1	0	1
	P. salicifolia	0	0	0	0
	P. salicina	0	29	40	39
	P. simonii	2	4	3	4
	P. spinosa	21	3	5	4
	P. subcordata	26	5	12	5
	P. texana	0	1 (1)	0	2
	P. tomentosa	55	16 (7) GN	6	26
	P. umbellata	0	0	0	0

[Z] Numbers with ( ) indicate number of accessions at other locations - National Arboretum (NA) for ornamentals, and the Geneva Clonal Repository (GN) for fruiting cherries.

MATERIAL THAT NEEDS TO BE COLLECTED

Gaps to be filled.

The species needed to preserve the diversity are listed and their priority for collection noted below. Thirty-six species not represented or needing greater representation are classed as high priority for collection. Eight Prunus species are listed as threatened species by the Center for Plant Conservation. They are *P. alleghaniensis*, *P. alleghaniensis* var. *davisae*, *P. geniculata*, *P. harvardii*, *P. maritima* var. *gravesii*, *P. minutiflora*, *P. murrayana* and *P. texana*. These should also be collected:

High Priority

Almond

P. argentea
P. bucharica
P. dulcis
P. fenzliana
P. petunnikowii
P. tenella (nana)
P. spinosissima - get from Spain collection.

Peach

P. davidiana - rootstocks.
P. kansuensis - not enough diversity, need for rootstocks.
P. mira - not in the collection in 1990.
P. persica - from China

Apricot

P. *ansu* - source of lower chill and disease resistance.
P. armeniaca - need material from SW Asia, Northern Egypt, Iran and Pakistan
P. x *dasycarpa* (collect as apricots are collected).
P. holosericea (Tibet, Sichuan - possibly endangered).
P. mandshurica - need more diversity from north east China.

Plum

P. alleghaniensis - threatened species
P. alleghaniensis var. *davisae* - threatened species
P. geniculata - native to Florida, endangered, drought tolerant
P. harvardii - threatened species, collected by Stephen Rieger.
P. hortulana - being lost?
P. maritima - collect because loss of material. Get NJ116 and clone from IR-2.
P. maritima var. *gravesii* - threatened species.
P. minutiflora - threatened species.
P. munsoniana - need before lost.
P. murrayana - threatened species, plant at Dallas, Texas Agricultural Research and Extension Center.
P. salicina - Chinese native species (*P. consociiflora, P. gymnodonta*).
P. simonii -
P. texana - threatened species.

Cherries

P. bifrons
P. glandulosa - need to collect wild types
P. fruticosa - need for dwarfing rootstocks and disease resistance.
P. maackii - need for disease resistance
P. japonica - not enough diversity, need for rootstocks.
P. maximowiczii - collect more, esp. low chill.
P. pleiocerasus
P. serotina - need large fruited types for disease resistance, cold hardiness, and medium chill adaptation.

Medium Priority

Almond

P. webbii - need more diversity.

Peach

none listed

Apricot

P. mume - need to collect fruiting hybrids from Taiwan, China and Japan.
P. siberica - collect seed

Plum

P. americana - Charlie Graham, Dick Okie, Tom Beckman, and Brian Smith have accessions.
P. angustifolia - Charlie Graham, David Byrne, Tom Beckman, and Dick Okie have collections.
P. cerasifera - (go to European collection for diversity)
P. fasciculata - need limited collection.
P. freemontii
P. gracilis
P. mexicana - David Byrne, Charlie Graham and Dick Okie have collections.
P. orthosepala - collect a few = complex Americana hybrid, get from Wayne Sherman
P. spinosa - need more variability
P. subcordata - collect more

Cherry

P. besseyi
P. padus - collect more
P. pumila -
P. spachiana - need more variability.
P. tomentosa - collect more from China.

<u>Low Priority</u>

Peach

none listed

Almond

none listed

Apricot

none listed

Plum

P. andersonii - need, but not being lost., some available commercially
P. nigra - need, but not being lost.
P. umbellata - get from Wayne Sherman, Charlie Graham, Tom Beckman, and Dick Okie.

Cherry

P. avium - medium chill, self fertile types from Mediterranean region.
P. cerasus - gaps being filled with Amy Iezzoni's material from PI.
P. emarginata - need, but not being lost.
P. pensylvanica - collect, but not being lost.
P. virginiana - get a few, get one with yellow fruit, also some from Soil Conservation Service.

<u>No Need to Collect</u>

P. laurocerasus - in the ornamental trade.

Funded Prunus Collection Efforts

1988 - Wm. Gustafson, Western China, Sinkiang Province - almond, wild *Prunus*
1988 - Maxine Thompson, Pakistan, apricots and almonds.
1990 - Thompson, Ramming, and Sperling - Central Asia/Russia, apricots
1995 - Weeks, west coast North American species
1995 - Parfitt and White, Turkmenistan (USAID), almond relatives, wild *Prunus*, 15 apricot cultivars
1998 - Iezzoni, Lang, and Karle. *Prunus avium* in the Ukraine
1998 - Forsline, Iezzoni, and Karle. *Prunus* and *Malus* germplasm in Russia.

The major gaps in the collection are the following

Prunus species native to North America
Peaches and apricots from China.
Plum species native to Asia
Almond cultivars and wild species from the collection in Zaragoza, Spain

B. Evaluation

Currently, there is limited evaluation being done, usually in connection with Enhancement Programs. Several programs have done isozyme and molecular marker studies (UC Davis, Texas A&M University, North Carolina State University, Clemson University, USDA-Kearneysville). Work is being done at ARS, Fresno, and GA on rootstock resistance to nematodes and other problems. A concerted effort needs to be developed to collect existing evaluation data and to evaluate material already in the United States, as well as material as it is introduced. This is hard to do without adequate plant material, particularly seeds for the species. Making seed available for evaluation is needed. A procedure for the systematic evaluation of Prunus is top priority.

Some of the traits that need to be evaluated are:

a. Fruit Characters -(see Appendix)
Size, blush, shape, firmness, ground color, flavor, flesh color, flesh type variation
b. Tree Growth Characteristics
Form
Dwarfing/Vigor
Spurriness
c. Fruit Characters - (Non routine)
Storage ability
d. Disease Resistance - Scion (see Table 3)
Bacterial leaf spot
Brown rot
Leaf spot
Peach leaf curl
Plum leaf scald
Powdery mildew
e. Disease Resistance - Rootstock
Phytophthora
Armillaria
Cotton root rot
f. Pest Resistance - Scion
g. Pest Resistance - Rootstock
Nematode resistance
h. Environmental Tolerance: Scion
Cold/Heat
Chilling
I. Environmental Tolerance: Rootstock
Nutrient stress - Calcareous and acid soil
Salinity stress
Water logging

There has been much discussion about the sanitary status of material entering and leaving the repository. There are several primary concerns.

1. The need to exclude new and exotic pest diseases when introducing plant material exists, but the introduction of material must be expedited! New pest disease detection and elimination procedures are essential.

2. Virus status of material needs to be known so dangerous diseases are not spread.

3. A balance between liberal and restricted distribution policies on virus status need to be established so the repository is able to distribute plant material in a reasonable manner without duplicating existing virus detection and clean stock programs.

C. Enhancement

All the active breeding programs listed earlier are doing germplasm enhancement to some extent so this is a less important role for the CGC. Enhancement does need to be continued with cooperative programs between enhancement programs. There is a need for improved scion and rootstocks. Currently, additional effort needs to be placed on collecting and establishing the germplasm at the repository so it is available to enhancement programs. Enhancement programs have already impacted the industry and they will continue to do so. One priority is the increased eating quality of our fresh fruit so consumers want to buy fruit a second time. The need for pest and disease resistance is high priority given the increasing restrictions placed on the use of pesticides.

D. Preservation - Storage

The number of collections and their contents has been mentioned. These collections are not adequate. Additional native North American species need to be collected. Species and clones from centers of origins (mainly eastern Europe to east coast of China, also including the middle eastern countries) need to be collected before these resources are lost due to cutting of forests or to the planting of only a few commercial cultivars in place of old land races. The greatest problem we have, once collections have been made, is getting material through plant quarantine. The facilities and personnel have not been adequate in the past, although given the new facilities, a new streamlined pathogen testing procedure, and other changes, the performance of the quarantine service should improve dramatically.

At the moment, the *Prunus* collection **is not backed** up within the National Plant Germplasm Repository system. Only live trees and dry seeds are available for use in storage which limits our ability to have backup collections. The repository has limited resources for this type storage and needs to explore alternative methods. Coordination between enhancement programs allows some preservation back-up to be done in breeder collections. The types of material that has potential for storage are:

1. Live plants: Can be stored in the field, and in tissue culture storage as a clean backup.

2. Cryopreservation: budwood in liquid nitrogen.

3. Seed: Storage conditions, storage period, and regeneration procedures need to be developed for *Prunus* for long term storage when possible species and clonal collections can be maintained.

4. Pollen: Can be stored for long periods. However, live plants are needed for regeneration, i.e. for receptors to the pollen, until direct regeneration methods are developed.

The flow of materials from the various working collections into the repository collections has been slow because of California quarantine regulations. These do not allow *Prunus* budwood entry from many regions within the United States. The CGC has reviewed this material in the National Clonal Repository at Davis, CA twice. This has lead to specific recommendations on the content of the collection and to the elimination of duplicates. The germplasm system must be sensitive to opportunities to add to collections and must be ready to acquire vulnerable germplasm should continuity of established collections become threatened or opportunity to add from world collections becomes available. Curators should bear prime responsibility for acquisition, but the CGCs need to supply the information that alerts the curator to opportunities and needs. The greatest restriction is in the screenhouse facilities which are barely adequate. Resources to expedite indexing activities and to provide descriptor information should be priorities. In addition to facilities, allocation of resources to support visiting scientists, post-docs or other support scientists would help bring broad expertise to bear on the needed activities of the repositories.

E. Recommendations

There are several areas that need attention.

1. The most important area is eliminating obstacles for the introduction of plant material into the United States. Although, the process has been improved over the past 10 years by prioritizing plant accessions, eliminating unimportant items and upgrading facilities and personnel, much still needs to be accomplished. Recently the indexing protocol has been streamlined so an item can be checked for diseases in 12-15 months instead of 4 to 6 years. This procedure is being established which should facilitate the entry of materials.

2. Much wild germplasm is being lost as native forests in China, Asia, Europe, and North America are destroyed. Local cultivars are also being replaced by “modern cultivars” from North America and Europe. This material needs to be collected before it is lost.

3. The National Clonal Germplasm Repository is in place at Davis for Prunus collections and needs continued support to function properly. Of prime importance is the need to establish a back up collection.

4. Finally, a scheme for evaluating the available germplasm (both at the Repository and at various other sites) needs to be developed so that information can go into GRIN and be made available to the public. The GRIN database needs to be checked for accuracy as well.

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Table 3.

MAJOR STONE FRUIT DISEASES		**SPECIES AFFECTED**					
Disease	**Causal Organism**	**Almonds**	**Peach**	**Plum**	**Apricot**	**Sweet Cherry**	**Tart Cherry**
Crown Gall	*Agrobacterium tumefaciens*	X	X	X	X	X	X
Bacterial Canker	*Pseudomonas syringae*	X	X+	X+	X+	X	X+
Bacterial Leaf Spot	*Xanthomonas pruni*/ or *compestris* cv *pruni*	X	X+	X+	X+		
Brown Rot	*Monilinia* spp.						
Peach Blight	*Coryneum*	X	X	X	X	X	X
Peach Twig Blight	*Glomerella cingulata*		X				
Crown Rot	*Phytophthora* spp.	X	X	X+	X	X	X
Peach Mildew	*Sphaerotheca*		X		X	X	X
Cytospora Canker	*Leucostoma*		X	X	X	X	X
Anthracnose	*Glomerella cingulata*	X	X	X			
Peach Leaf Curl	*Taphrina deformans*	X+	X+	X+	X-		
Verticillium Wilt	*Verticillium* spp.	X	X				
Cherry Leaf Spot	*Coccomyces* spp.			X		X+	X
Black Knot	*Dibotryon morbosum*			X			
Peach Scab	*Cladosporium carpophilum*		X		X		
Oak Root Rot	*Armillaria spp*	X	X	X+	X	X	X
Clitocybe Root Rot	*Clitocybe*						
Cotton Root Rot	*Phymatotrichum omnivorum*	X	X	X	X	X	X
Gummosis	*Botryosphaeria* spp.		X				
Rust	*Tranzschelia discolor*		X				
Rhizopus Rot	*Rhizopus nigricans*	X	X	X	X	X	X
Phony peach/plum leaf scald	*xylella fastidiosa*	X	X	X+	X		
Viruses	Prune dwarf		X	X	X	X	X
	Green ring mottle		X	X	X	X	X
	Tomato ring spot	X	X	X	X		
	Plum pox		X	X+	X+	X	X
	Peach yellows	X	X	X	X	+	+
	Peach Rosette		X	X	X	X	X
	Little Peach	X	X	X	X	+	+
	Peach Mosaic	x	X	X	X	+	+
	Albino Cherry					X	X
	X-disease (mycoplasma)	X	X	X	X	X	X
	Prunus Necrotic Ring Spot		X	X	X	X	X

Table 4.

MAJOR PESTS OF STONE FRUITS **SPECIES AFFECTED**

Pest	Almonds	Peach	Plum	Apricot	Sweet Cherry	Tart Cherry
Plum Curculio		X	X	X		
Tarnished Plant Bug		X	X	X		
Stink Bug		X	X	X		
Thrips		X				
Oriental Fruit Moth	X	X	X	X		
Codling Moth		X	X	X		
Japanese Beetle		X	X	X	X	X
Green June Beetle		X	X	X	X	X
Twig Borer	X					
Peach Tree Borer	X	X	X	X	X	X
Lesser Peach Tree Borer	X	X	X	X	X	X
Shot Hole Borer	X	X	X	X	X	X
Ambrosia Beetle		X	X	X		
Aphids	X	X	X	X	X	X
Mites	X	X	X	X	X	X
Scales	X	X	X	X	X	X
Navel Orangeworm	X					
Fruit Flies		X	X	X	X	X
Nematodes	X	X	X	X	X	X

Table 5.

MAJOR ENVIRONMENTAL HAZARDS OF STONE FRUITS **SPECIES AFFECTED**

Environmental Condition	Peach	Plum	Apricot	Sweet Cherry	Tart Cherry
Freeze and frost injury	X	X	X	X	X
Drought tolerance	X	X	X	X	X
Water logging	X	X	X	X	X
Soil pH - high and low	X	X	X	X	X
Mineral uptake efficiency	X	X	X	X	X
Heat stress	X	X	X	X	X
Salinity (Sodium and calcium salts)	X	X	X	X	X
Chilling requirement	X	X	X	X	X
Soil hardpans	X	X	X	X	X
Air pollutants	X	X	X	X	X

Table 6.

STONE FRUIT TREE AND FRUIT CHARACTERISTICS **SPECIES AFFECTED**

Characteristic	Almonds	Peach	Plum	Apricot	Sweet Cherry	Tart Cherry
Extension of maturity season	X	X	X	X	X	X
Cracking resistance	X	X	X	X	X	X
Fruit size	X	X	X	X	X	X
Fruit quality	X	X	X	X	X	X
Fruit firmness		X	X	X	X	X
Uniform ripening	X	X	X	X	X	X
Tree vigor and structure	X	X	X	X	X	X
Adaptation to mechanization	X	X	X	X	X	X
Tree longevity	X	X	X	X	X	X
Shipping and storage		X	X	X	X	X